DEMYSTIFYING "DESIGN RESEARCH":
DESIGN IS NOT RESEARCH, RESEARCH IS DESIGN

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ABSTRACT

In the fields of design, ranging from the arts to technology and computer engineering, the phrase "design research" has numerous uses and meanings. There are many ways (indeed, perhaps an infinite number of ways) that such research can be performed, and many ways that design can manifest "research." This paper compares and contrasts variant approaches to design research practice, as described in recent literature on design, to discuss how design and research both benefit from a holistic understanding of the design research landscape. While practicing designers tend to know exactly what they mean when describing their activities as "research," more rigorously oriented academic or technical researchers are easily confused by the vagaries of design. Moreover, designers do not necessarily take the functional "research value" of traditional research approaches for granted, since despite the theoretical and empirical rigor of these methods they may not actionably address real human needs in meaningful ways.

This work identifies four basic categories of "design research" to clarify the differing intents and objectives of designers across disciplines of research. They are: (1) design through research, wherein researchers perform activities that would conventionally be considered "research"—regardless of their awareness that their activities are "design"; (2) design of research, the activities routinely performed by researchers to plan and evaluate their experimental designs; (3) research on design, wherein researchers interested in improving design practice examine it, often by studying design practitioners at work or manipulating experimental variables to influence design behaviors and outcomes, thereby revealing relevant design process knowledge; and (4) research through design, wherein designers design things "as usual" but consider their results research because, in addition to shaping tangible outcomes, they have learned something new about their practice. While all of these approaches are commonly employed, only research on design and research through design fully engage the "designerly ethos" of design (Cross 2007). In other words, traditional research (i.e. design through research and design of research) employs conventional methods, but research on design and research through design result in the creative "design of design." Consequently, these approaches are less easily embraced by researchers as rigorously "scientific" despite their proven effectiveness at improving research practice.

1. INTRODUCTION

The past decade has seen tremendous interest in design and "design research" from a multitude of perspectives in industry and academia. Indeed, the term "design research" has become part of the common vernacular in the field of design and is increasingly used to describe a myriad of possible approaches, perspectives, philosophies and methods. To give just one example, design research conducted by academics—which tends to lead to insights documented in scientific publications—is drastically different from research conducted by product design practitioners where the intent is to capture design insights and embed them in artifacts. This paper compares and contrasts variant approaches to design research practice, as described in recent literature on design, to discuss how design and research both benefit from a holistic understanding of the design research landscape. Our aim is to provide a useful framework for understanding the relationship between research and design by which design researchers will be able to situate their work in the larger research landscape, and explain their activities more clearly to others.

Research is generally defined as a systematic investigation that establishes novel facts, solves new or existing problems, proves new ideas, or develops new theories. It is primarily associated with the search for knowledge, especially in the sciences and technological fields. Design, in contrast, deals with the act of planning and communicating a course of action to others, usually through the creative exploration of an area of interest. Charles Eames defined design as "A plan for arranging elements in such a way as to best accomplish a particular purpose." (Neuhart et al. 1989) The term "design research" combines these two reasonably well-understood areas of practice, research and design, resulting in a seemingly meaningful merger roughly equivalent to the investigation of knowledge through purposeful design. In this regard numerous authors have articulated design research as both the *study of* design and the process of knowledge production that occurs *through the act of* design (e.g. Biggs 2002, Laurel 2003, Fallman 2007, Koskinen et al 2011). Yet because the term has become so broadly used in practice without being fully understood beyond the conjunction of design with research, particularly in academic circles, it has come to mean widely differing things to different people. Indeed, Krippendorff (2007) has argued that in actuality design research is an oxymoron "whose contradictions, because they are not obvious to everyone, can lead its naïve users into thinking of it as a kind of research similar to what reputable scientists do." Rather, a comprehensive understanding of the term requires sensitivity to the cultural nuances and contextual differences across subdomains of research and design.

For the purposes of this investigation, we will begin by separating the various meanings of "design research" into two main categories: design as a "kind" of research, and design research as an aspect of a larger design process. Each of these approaches will be discussed in turn.

1.1. DESIGN AS A "KIND" OF RESEARCH

The various domains of research can generally be divided across two axes: *Scientific vs. Practice-based*, and *Theoretical vs. Empirical*, as shown in figure 1. Fields such as mathematics, physics and biology, on the left side of this framework, are all varieties of so-called "basic" research: they are systematic activities carried out to increase knowledge of fundamental and replicable principles for understanding the physical world. Relative to these approaches, design-related activities—while potentially scientific and experimental in some regards—are more appropriately situated on the right of this matrix. There is generally a broad consensus that the numerous fields of design are most accurately framed as varieties of "practice-based" research since they are realized through the practice of doing design (Zimmerman et al. 2010). In this regard design research is closely related to other kinds of research performed in the arts and humanities, applied engineering, and the many activities performed by historians, anthropologists, sociologists and linguists.
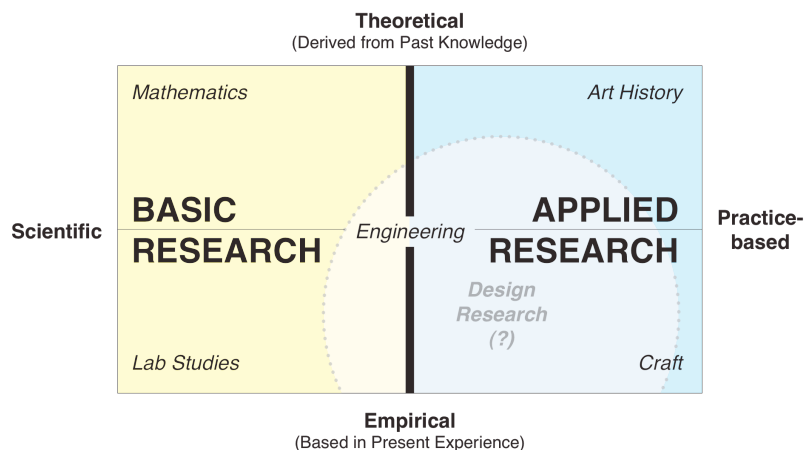

Figure 1. Kinds of research.

The second aspect this diagram makes clear is the degree to which a field of research is based on directly observed empirical experience (bottom) vs. theoretically derived prior knowledge (top). Most traditional research has tended to focus on two main strategies for insuring success: inductive reasoning (determining "what is so" from empirical observation), and deductive reasoning (deriving "what must be so" from prior knowledge). Designing possible futures requires a third kind of logic: abductive reasoning,

or the process of envisioning "what might be so" (Kolko 2010). In most technology research, abduction is present in the form of hypotheses (or "best guesses") that are subsequently tested through experimentation. Because the abductive activities associated with design research are necessarily rooted in experience (Forlizzi and Battarbee 2004), we feel that design research is a subset of research activity located roughly in the lower-right quadrant of figure 1. This positioning frames it as a kind of empirically-oriented and "applied" approach to knowledge discovery and creation.

When design is viewed as a kind of research, it tends to be done so in a context that values the creation of knowledge. This could be the study of materials, technologies, design methodologies, design theories, manufacturing processes, the implications and impact of design on the world, and so on. It could also involve educational, historical or critical approaches. In academic practice, for example, faculty are required to perform research in their field that is likely to be inherently biased towards a set of conventional methods. Much like the practicing designer, however, some design academics may also approach their research directly through the design of objects, interactions, services, etc. Their creation of new knowledge may be a new idea, way of working, or a conceptually visionary experimentation. In all of these cases, the methods employed as a part of the research practice directly influence the nature of the knowledge produced.

Based on the richness and variety of available methods for research and design, the lack of common vocabulary to help clarify what is meant when a designer or academic proclaims to be doing "design research" is not surprising. This said, it is important to distinguish between knowledge created during the "act of design" and that which results from the "study of design." The former is more likely to use methods and processes that look like design to outsiders, while the latter may be indistinguishable from other more theoretical or empirical research approaches. While both are motivated by the desire to generate new knowledge, such knowledge may have different uses depending on its specific field and purpose. Perhaps most importantly, because the knowledge itself is "new" it will necessarily propagate new ways of thinking. This in turn will impact the subfield of research in question by inspiring innovative thinking, delivering fresh design solutions, and informing new ways of evolving the research process.

1.2. RESEARCH AS A "PART" OF DESIGN PRACTICE AT LARGE

Another way to conceive of design research is to consider the activities that it tends to comprise. Design practitioners engage in research for a multitude of reasons, which may include seeking inspiration, evaluating existing solutions and approaches to similar problems, identifying user needs, testing the usability of concepts, finding and experimenting with different materials, predicting the marketability of an idea, and so on. Often times, depending on the project, professional designers will only engage in a subset of these activities. Usually the data from this research results in general parameters to guide the design, as opposed to directly impacting how the designer will implement the design. When designing a quiet and inexpensive computer printer, for example, Bone and Johnson (2009) describe a process in which they looked to bondage techniques and fabric padding. While this resulted in a strong conceptual design made of felt, it was also an atypical approach to design: it examined neither the most obvious engineering solutions or variant methods of sound reduction. This example demonstrates that while the results of design research activities are always new knowledge, they may not be intended for generalizable use or application beyond the local context or project for which they are performed. Furthermore, because there are many ways that design can manifest "research-like" activities, and no shortage of places to learn how to do so, describing a set of design activities as "design research" without additional specification is often too vague to be truly meaningful in practical communication.

In general, we find that design research approaches tend to fall into one of three categories. Some design research is empirically oriented, based on direct observation of the physical world through qualitative research observing people in context to identify needs and frame opportunities (Faste 1987, Patnaik and Becker 1999, Salvador et al. 1999). Other research focuses on the practice of design as an aesthetically informed form-giving "craft," wherein designers engage in iterative prototyping of forms and experiences to determine their usefulness and usability, often employing field trials and participatory co-design sessions (Smets et al. 1994, Sanders and Stappers 2008). Still others engage in speculative or otherwise theoretical or critical approaches to design that involve systematic probes and interventions into cultural discourse and practice (e.g. Gaver et al. 1999, Dunne and Raby 2001). While each of these activities qualifies as design research, the differences between them can be significant.

In the first case, design research risks becoming synonymous with "ethnographic research" or "qualitative fieldwork" in general. Ethnographic research is used by anthropologists to empirically study the behaviors of social groups (Patton 2002). While the same basic premise is widely utilized in "human-centered" design processes, albeit in less anthropologically rigorous ways, such approaches constitute just one of countless possible data gathering and synthesis strategies. Indeed, ultimately the goal of the designer is to improve things, not study them, and this necessarily involves the creation of new kinds of techniques. As Faste (1995) observes, "A designer doesn't really want to become an anthropologist (and go into situations with no hypothesis), or a historian (and go to the original source material while keeping hands off the present), or a sociologist. Design research is really about the design of design."

The second kind of design research—formgiving—demonstrates that design research is necessarily situated in the context of real-world design practice. Design research that engages in the generation of form is intrinsically embedded in the media it uses as a means of expression. Increasingly such artifact creation spans a variety of technology platforms and differs greatly from the traditional foci of academic "study." Because such research practices involve synthesizing many disparate pieces of information, the articulation of form could include responses to data from previous research studies and involve numerous approaches such as storyboard sketching, idea brainstorming, technology development, physical or interactive prototyping, manufacturing experiments, evaluation with users, and so on. Unlike analytically reductive research methods, the end result of such approaches tends to be guided by numerous interdependent variables and the results of such explorations are seldom repeatable. As a consequence, the criteria for success in this kind of research is necessarily variable and depends on the nuances of the process performed. Moreover, designers may not take the "research value" of prior research for granted if it has not followed a rigorous process of defining and addressing relevant underlying human needs and values.

Designers tend to use a wide variety of research methods when pragmatically appropriate, some rigorously scientific and others less so. Often this range of approaches serves as an exploratory foundation to help frame alternatives and generate design directions. Rapidly expressing numerous hypothetical ideas allows possibilities to be quickly tested and the best solutions refined. The third kind of design research—critical design—takes these approaches to an extreme. By speculatively prototyping science fiction scenarios, for example, such hypotheses can be documented or realized and injected into unsuspecting cultural contexts to provoke a response. In this regard the designer's objective is to create objects or experiences that work primarily to achieve a desired emotion, behavior, or function (Bardzell et al. 2012). This accounts for many designers' indifference towards clear and thorough scientific justification or documentary rigor, as the precise links between theory and the resulting knowledge need not be clearly articulated to achieve successful results. It also places such research in an excellent position, when successful, to critique the conventional approaches by which design problems are solved.

In conclusion, while researchers often frame design as a "kind" of research, designers are more likely to consider a multitude of research approaches as integral to their practice at large. Thus while typical research tends to have the goal of narrowing its focus towards specific solutions to well-defined problems, design research often results in a broadened understanding of the problem domain and many alternative potential solutions. In this regard, as Krippendorff (2007) observes, "'Design research' is an oxymoron without question. As a subspecies of research, design research suppresses design."

2. DESIGN IS NOT RESEACH, RESEARCH IS DESIGN

Our discussion thus far has described how design research is often considered a subset of research practice by the "scientific left," and an aspect of more holistic design processes by the "designerly right." While both of these positions are commonly held and have their practical merits, it is our experience that each viewpoint can benefit from a wider perspective. Specifically, while technologically-driven research fields are often inclined to consider design a "kind" of research, more often the opposite is actually true: science is one approach, of many, to the practice of design. Scientific research uses known and replicable methods; "design research" is often unreplicable and hard to pin down. It addresses intrinsic human needs that may not be easily generalized, creates and employs unconventional methods on the fly, and delivers results that are challenging if not impossible to systematically reproduce. This has the desired result of

achieving meaningful impact, but it does so in a way that is difficult to reconcile with traditional research methods. Thus while it is reasonable to frame design research as a subset of design, it is also unrealistic to consider such activities "research" in any conventional sense.

Instead, we propose the simple idea that design research is not a "kind" of research, but rather that research is always a "kind" of design (figure 2). In this more appropriate framing, "practice" is the super-set: clearly scientists "practice" research just as designers naturally practice design. Furthermore, the approaches traditionally referred to as "research" include only those aspects of design that are conventionally accepted as research approaches. "Design research" is therefore creative research. It contains a subset of possible design-oriented strategies and, as design research methods become conventional, new unconventional methods arise to replace them. This model makes clear that all research is a subset of design practice at large, and that design research is simply the set of such methods not conventionally considered to be research.
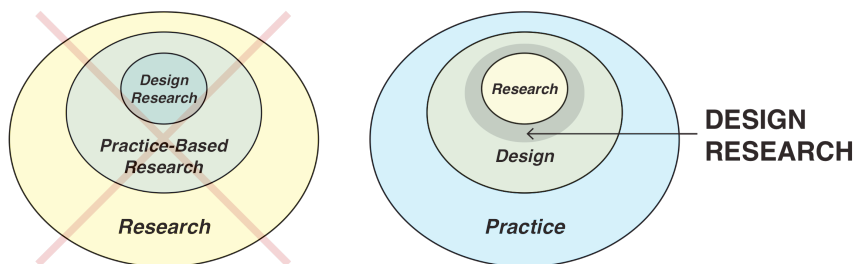

Figure 2. Design research is not a "kind" of research. Rather, research is a practice, and it is part of design practice.

The implications of this reversal are particularly relevant for design academics since they are charged with performing scholarly research in the field of design. To most academics such targeted research is the norm; an art historian, for example, will "practice" their profession through research resulting in scholarly articles or books. Yet because design, like art, is a "practice-based" discipline, when designers perform research they are engaged with only a relatively small set of design practices at large. Indeed, because design is an intrinsically holistic activity but design research constitutes only some aspects of its practice, the design academic faces greater limitations than researchers in many other fields. To avoid this dilemma, enlightened university departments consider "research" in this field to have a definition more in line with "creative practice" and thus a wider scope of expected outcomes, such as objects and exhibitions. This poses a challenge for inter- and cross-disciplinary design research evaluation in technical fields such as engineering and human-computer interaction, however, especially as design has become increasingly essential to their success.

We therefore propose an improved taxonomy of design research approaches that more accurately reflects the various kinds of activities that design researchers may be expected to perform (figure 3). A simple 2x2 matrix has been used to illustrate the differences and similarities between four interconnected categories of design research practice. In this model the totality of "design research" as a discipline is defined by two axes. The horizontal axis reflects "research" on the left and "design" on the right. This axis describes the differing perceptions of how design research is "expected to behave" across disciplinary boundaries. We should also reiterate that "research" is a subset of design activity, as described above. As a result, the left-half of the diagram is a "subset" of the right, and involves a more focused and reductive approach relative to the holistic and varied designerly approaches studied and employed on the right. The vertical axis represents the degree of a practitioner's involvement in the activities being performed, from "hands on" at the bottom to "hands off" at the top. This distinction allows us to see that the top two quadrants are more focused on the practical and strategic analysis of design research planning, whereas the bottom two quadrants are more deeply immersed in the act of experiencing the knowledge in question firsthand. The vertical axis also reveals that the top two quadrants are discrete components of the quadrants below them and, as a consequence, the lower quadrants are guided in part by the work of their neighbors above. The following sections describe each of the four quadrants in turn, beginning in the lower-left quadrant and proceeding clockwise.
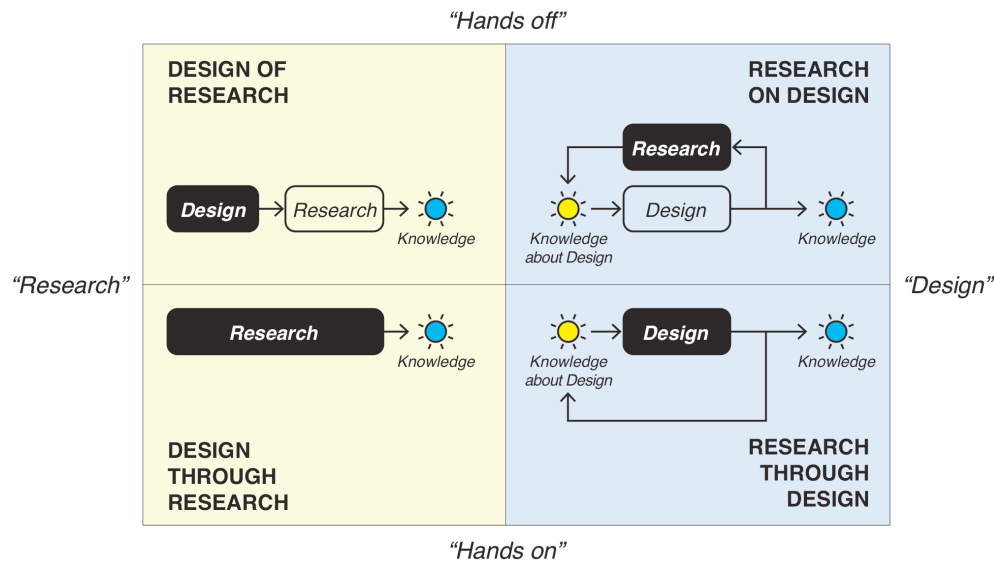
Figure 3. Four categories of design research: (1) *design through research*, wherein researchers perform activities that would conventionally be considered "research"—regardless of their awareness that their activities are "design"; (2) *design of research*, the activities routinely performed by researchers to plan and evaluate their experimental designs; (3) *research on design*, wherein researchers study design practice at work, thereby revealing relevant process knowledge; and (4) *research through design*, wherein designers design things "as usual" but consider their results research because, in addition to shaping tangible outcomes, they have learned something new about their practice.

2.1. DESIGN THROUGH RESEARCH (STUDIOUS DESIGN RESEARCH)

The first category of design research is design through research (i.e., research). This category reiterates our framing of research as a kind of design. We also refer to this quadrant as *studious* design research, because design research of this nature explicitly studies natural and technological phenomena to advance human knowledge. For all practical purposes, studious design research is synonymous with the research practices of other conventional fields of research, that is, research practitioners are always studious design researchers regardless of their awareness that their activities are "design."

2.2. DESIGN OF RESEARCH (FORMATIVE DESIGN RESEARCH)

The second category of design research is the design of research. Like studious design research, formative design research has its basis in scientific convention. This quadrant reflects a critical aspect of design through research: it is the process by which research activities are routinely designed. We therefore refer to this quadrant as *formative* design research, as it is the domain in which research is planned and given form. Much has been written about the nuances of research design, including qualitative, quantitative, and mixed methods approaches (e.g. Creswell 2002), and there is little need to address it deeply here. This said, it should be emphasized that formative design research is critical to all varieties of design research practice as it defines the intent of the designer performing the research activity. Furthermore, since formative design research is often used to plan out a design process it can be effectively considered the deliberate "design of design."

2.3. RESEARCH ON DESIGN (DIAGNOSTIC DESIGN RESEARCH)

The third category of design research, "hands off" and designerly, is research on design. The continued growth and success of design requires that designers improve their practice, and research on design is one such approach. Design research in this quadrant performs the critical role of examining design processes to enhance the effectiveness and efficiency of a given design method or process. We refer to this quadrant as *diagnostic* design research, as it is here that researchers interested in improving design practice observe it and diagnose it directly—often by studying design practitioners at work or manipulating experimental variables to influence design behaviors and outcomes. By revealing relevant design process knowledge, research on design has the power to empirically validate the effectiveness of a given design

practice, such as the best mechanisms for collaboration in design teams (Brereton et al. 1996) or prototyping dynamics (Dow et al. 2011). Although the analysis of design activity allows patterns in the relative success of certain activities or approaches to be recognized and determined, research on design is limited to that which can be empirically analyzed. In this regard diagnostic design research could be seen to provide little value to "designerly" research practitioners, who tend to have a very good sense of what works for their practice (Cross 2007). This said, research on design plays a vital role in legitimating and establishing design methods within the scientific community at large.

2.4. RESEARCH THROUGH DESIGN (EMBEDDED DESIGN RESEARCH)

In this final category of design research, a combination of process and research culminate in an artifact as the embodiment of design research knowledge (e.g., an object, process, interaction, experience). Just as design through research articulated the often unknowing involvement of performing design, research through design is design activity that operates as research—whether intentionally or not. For this reason we refer to it as *embedded* design research: the knowledge generated is contained in the cognitive processes and artifacts of the design activity performed. Research through design is not limited to traditional research documentation and, in this regard, is closely related to research through practice in disciplines such as studio art where similar processes result in the creation of experienced artifacts (Koskinen et al. 2011).

Because artists and designers use research to understand the topics they are working on as a process of creation and self-reflection, they are able to improve their design research practice in ways similar to diagnostic design research methods. A major difference, however, is that design process knowledge is embedded in the designer's internal toolkit as well as in the external world as a result of the generated designs. In this regard embedded design research enables the enhanced performance of future design action through knowledge disseminated through broader means than that of traditional research. It encompasses artifacts in addition to indirect oral traditions, and propagates in aesthetically and emotionally meaningful ways. Indeed, design objects are presented as arguments for interpretation by their intended audience, forming a critical triad of discourse between the designer, the artifact, and the social environment that the artifact influences. As Biggs (2002) observes, "This implies the notion that the artifact can embody the answer to the research question." Embedding knowledge in the designers' activity not only enhances design research, it plays a vital role in the dissemination of knowledge across all forms of experience.

3. DISCUSSION

Design is a holistic endeavor that involves the synthesis of numerous different concerns. It investigates and integrates disparate forms of knowledge, and necessitates research to advance understanding. The concerns of design include functional and technological systems, as well as empathy with human needs and the expression of aesthetic and usable forms and solutions. The desire to create innovative responses to problematic conditions requires that designers have fluency with prior knowledge and proficiency testing and evaluating both function and meaning. As the intersection of these concerns, design research extends the value of design approaches to the research community, and impacts numerous fields with shared concerns through the practice it delivers to improve cultural systems.

This paper has defined four basic categories of design research to clarify the differing intents and objectives of designers across disciplines of research. The first is studious design research, or design through research, where traditional research activities seek to verify research hypotheses with or without the acknowledgement that such activities are design. The second is formative design research, or the design of research, which describes the creative activities of planning and preparation for subsequent empirical or theoretical research. The third is diagnostic design research, or research on design, wherein researchers systematically examine various design processes in order to improve the future practice of design. And the fourth is embedded design research, or research through design, wherein designers practice their craft in the pursuit of knowledge and by doing so gain insight into possible outcomes. While all of these approaches are commonly employed, each has its own unique characteristics and meaning. As design-oriented approaches, for example, both diagnostic and embedded design research are steeped in tacit and performative characteristics of creative design practice. Studious and formative design research, on the other hand, underscore the power and pervasiveness of conventional approaches to design. All of the quadrants are critical to the underlying functions of design as an accepted research method. Finally,

these various classifications of design research illustrate the need for both analytical and holistic thinking in integrated design practice. The focused empirical studies of studious and diagnostic design research would not be possible without the rigors made possible by formative discipline. Formative and embedded design research, however, necessitate the centrality of creative thinking in research and the contextual awareness and adaptivity required to achieve their desired results.

This paper, based on a review of recent literature in addition to our firsthand experience as researchers in design, is an example of diagnostic research through design. It is our hope that the approach we have taken helps to clarify and simplify the process of describing the nuances of design research, especially to those interested in expanding the creative fringes of design research practice.

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